Final Report
on
Hazards Monitoring
At NASA Merritt Island Launch Area

VOLUME I

Task A -- Sensor Selection and Location for Apollo Fuel Transfer and Tanking System

Contract No. NAS10-2009

National Aeronautics and Space Administration
John F. Kennedy Space Center
Cocoa Beach, Florida 32931

Melpar, Inc.
3000 Arlington Boulevard
Falls Church, Virginia 22046

November 1965

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

1. INTRODUCTION

This report describes the effort and results of Task A, subtasks 1, 2, and 3 of Contract No. NAS10-2009 as ammended between NASA-KSC and Melpar, Inc. Task A consisted of the selection of hazards monitoring sensors and the recommendation of suitable monitoring locations. A detailed analysis of fuel and oxidizer flow derived from drawing set 75M14574 served as the basis for the sensor selections and locations.

The remaining three tasks of Contract No. NAS10-2009 are discussed in three additional volumes.

Volume II, Task B -- Ultrasonic Leak Detectors for Cryogenics and Gases

Volume III, Task C -- Data Display and Transmission System

Volume IV, Task D -- Measurements of Incident and Reflected UV and IR Electromagnetic Background at Saturn Complex 37.

2. FUEL AND OXIDIZER SYSTEM MONITORING

2.1 Hypergolic Systems

Leakage of components of the hypergolic fuel and oxidizer system presents a two-fold problem in that the vapors themselves are toxic and constitute a serious personnel hazard, and the materials are self igniting when in contact with each other. Generally, the fuel and oxidizer lines are separated by a considerable distance on the arming tower, but must of necessity be much closer together as they near the vehicle into which they will be loaded. Therefore, while single detectors can be used at a number of locations, dual detectors, i.e., detectors for both constituents, must be placed at those locations where a strong likelihood exists that more than one vapor could be present at any time. This condition exists near the 264-foot level where both the fuel and oxidizer pass through manifolds and then ascend to the manned modules at the 310-foot level.

Toxic hazards will exist for personnel in the vicinity of lines carrying the fuel and oxidizer or the vapor from these materials. Areas of particular concern include the ground-tower interface, transport units, pumping station manifolds, and quick-disconnects. Leaks at permanent pipe joints, while possible, are much less likely than at joints that are connected prior to launch and are disconnected afterwards. Manifold valves should be closely monitored because moving parts are subject to wear and have a higher probability of leakage than fixed components.

The object of this study is to define, insofar as possible, the areas where hazards are likely to develop and to seek methods for providing rapid notice to cognizant personnel of the existence of hazardous conditions in

areas which may endanger personnel on the installation. While it is not possible to foresee and prepare for all eventualities, those areas which are most vulnerable to damage and the areas where personnel are likely to be present must be monitored closely, in order to take expeditious remedial measures. Examples of these areas are the quick-disconnects near the LEM in the first case and the fuel transporter in the second.

A quick-disconnect fitting, by its very nature, presents one of the more serious problems encountered in the design of a hazards monitoring system. In order to operate, a quick-disconnect joint (or QD as it is usually called) must be a relatively loose fitting joint. Often, but not necessarily,it is mounted on a flexible arm and must provide a leak-free joint, yet must disconnect on command, sealing itself as it separates from the other half of the joint. In order to accomplish these ends, extremely close tolerances must be met, and the joint frequently must be discarded after launch because of distortion resulting from exposure to undue stress, etc. Because of these considerations, close monitoring at these joints is required.

2.2 Cryogenic Systems

The principal cryogenic systems located on the Mobile Arming Tower (MAT) are concerned with the fuel cells and the supply of breathing oxygen. These are relatively small diameter lines and are subjected to much less stress than those utilized for primary vehicle fueling. Despite the much smaller amounts of cryogenic liquids transferred through these lines, the hazard is only slightly reduced, for any hydrogen leak, no matter how small, is dangerous.

The LH_2 and LOX lines ascend the fuel and oxidizer sides of the MAT, respectively, and are shown schematically in figure 1.

2.3 Terminology

Recommendations of locations to be monitored include those areas of the hypergolic and cryogenic lines associated with the spacecraft fueling system. These lines are carried on the MAT and are described on a set of 148 drawings, No. 75M14574, entitled "Launch Complex 39A, Spacecraft Support Systems Piping," originated at Huntsville, Alabama, by the Launch Support Equipment Engineering Division, dated 8 January 1965.

The more unusual abbreviations which have been used in this report are listed in table 1.

TABLE 1

ABBREVIATIONS

Symbol	Meaning
FH	Flexible hose
QD	Quick disconnect
CL	Connecting lines
FC	Flange connection
MV	Manual valve
PRV	Pressure relief valve
BAY	Special bayonet disconnect
LN	Line weld connection
IT	Interface tower

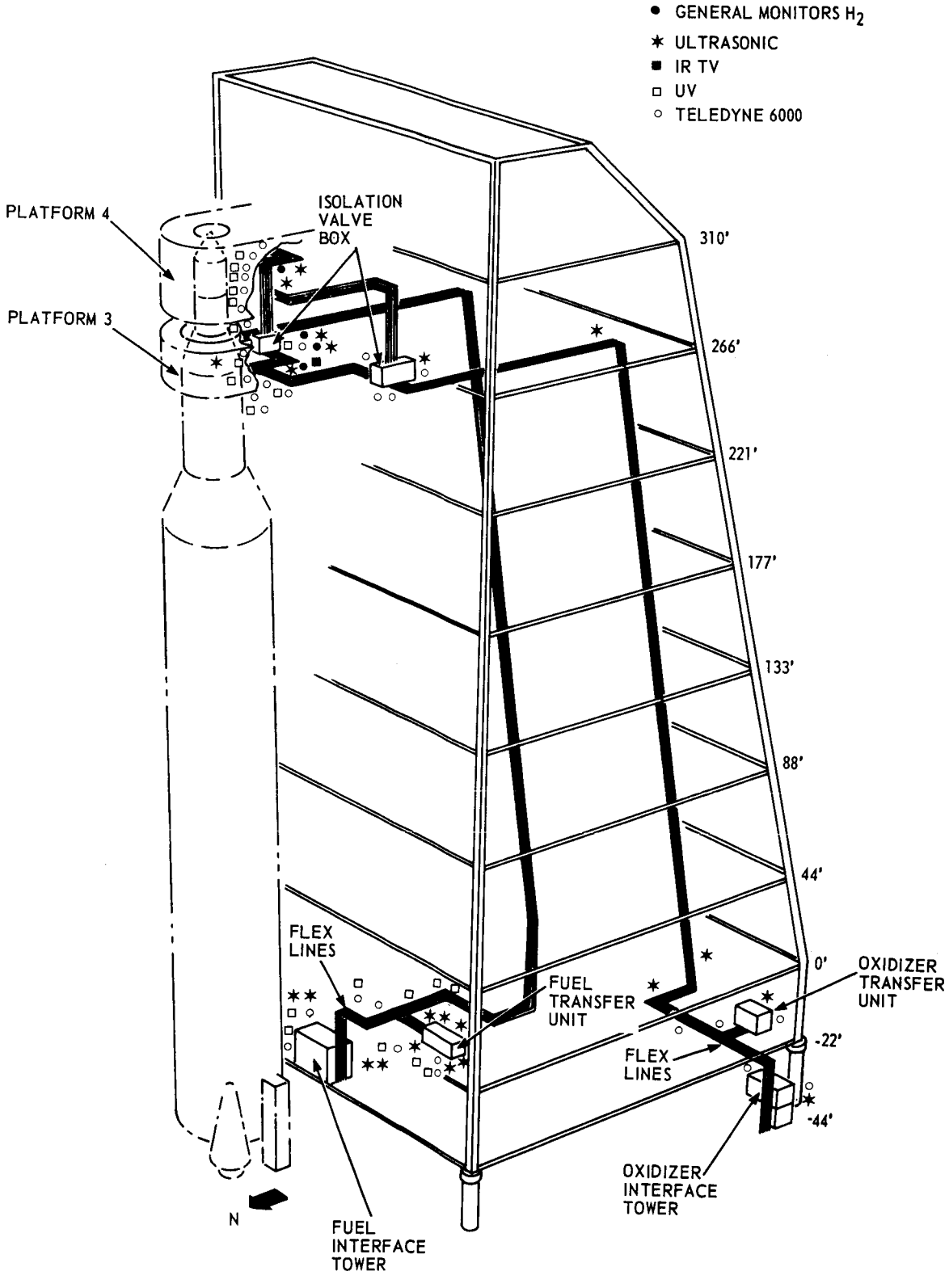

Figure 1. Mobile Arming Tower Fueling and Monitoring System

3. HAZARDS DETECTION INSTRUMENTS

As discussed in previous reports[1] relatively few applicable detection principles exist for the detection of the chemical hazards at LC-39. Basically, these are: ultrasonic detectors for cryogenic and pressurized gas leaks, ultraviolet and infrared sensing devices, including television for fire detection, micro-fuel cell and thin-film resistance systems for hypergolics and toxic vapors, hot wire bridges for hydrogen, and paramagnetic systems for oxygen.

Recommended instrumentation and manufacturers have been discussed previously and will not be repeated here. One exception to this relates to ultrasonic detectors which have been examined in detail during this study and are discussed in a separate section. Recommendations for modification of the detectors necessary to utilize the system for the detection of cryogenic leaks are included.

The sensors recommended for use in the hazards monitoring system based on their suitability and availability are shown in table 2.

---

1. Volumes I and II, Design Specifications, System for Detecting, Monitoring, Displaying, and Recording Hazardous Operation Information, NASA Contract No. NAS 10-1420, September 1964.

TABLE 2

RECOMMENDED SENSORS

Condition Sensed	Manufacturer or Type	Code (Used in Tables)
Hypergolics:	Teledyne Series 6000	5
Hydrogen:	General Monitors	1
Oxygen:	L and N Paramagnetic O_2 Detector	-
Cryogenics:	Modified Ultrasonics	2
Fire:	Honeywell UV Detection	4
	GDA IR-TV Systems	3

4. SENSOR PLACEMENT

4.1 Critical and Noncritical Areas

The following areas are considered critical and should receive primary consideration for monitoring:

a. Valve boxes.
b. Manifolds.
c. Quick disconnects.
d. Manual valves.
e. Flex hoses.
f. Interface areas.
g. Storage areas.
h. Transfer systems.
i. Disposal area.

Areas which are expected to be noncritical include:

a. Line caps.
b. Tees.
c. Connecting lines.
d. Check valves.

4.2 Specific Recommended Sensor Locations

A detailed analysis of fuel and oxidizer flow derived from drawing set 75M14574 (see tables A-1 through A-30 of appendix A) was the basis for the sensor selection and location recommendations. Specific recommendations of areas, levels, locations, and sensor types are given in tables 3 through 9.

In addition to the sensors and locations listed in the tables, it is recommended that IR TV's be situated to monitor the MAT IT interfaces, one corner each; total two. The hydrogen and oxygen lines are in proximity on both platforms 3 and 4. One IR TV camera should also monitor each of these locations making a total of four IR TV systems required.

TABLE 3

HYPERGOLIC FUEL VAPOR LINES*

Area	Level	Location	Sensor Type
MAT	-22 ft 0 in.	QDA19969 Purge manifold #7	5
MAT IT	0 ft 0 in.	QDA19970 QDA19971	5
Pad	15 ft	Purge manifold #6	4,5
Transfer unit	-	QDA19949	4,5
Storage unit	-	QDA19989	4,5
Disposal unit	-	QDA19984	4,5
Fuel isolation valve box	264 ft 3 in.	QDA20036 QDA19950	4,5
MAT	-22 ft 0 in.	Purge manifold #8	4,5
SM/LEM fuel servicing unit	-22 ft 0 in.	QDA19951	4,5
Platform 3 LEM valve box	264 ft 3 in.	Line cap QDA20020	4,5
Platform III	264 ft 3 in.	Purge manifold #9	4,5
Platform IVA SM valve box	310 ft	QDA20049 Purge manifold #10	4,5

*Refer to tables A-1 and A-2 of appendix A.

Recommended number of sensors: Type 4: 10; Type 5: 12.

TABLE 4

HYPERGOLIC OXIDIZER VAPOR LINES*

Area	Level	Location	Sensor Type
RCS oxidizer isolation valve box	264 ft 3 in.	QDA19821	5
MAT	-22 ft 0 in.	Purge manifold #3	5
MAT oxidizer servicing unit	-22 ft 0 in.	QDA19820	
Platform III	264 ft 3 in.	Oxidizer valve box, LEM	5
Platform III	264 ft 3 in.	Purge manifold #4	5
MAT isolation valve box (RCS)	264 ft 3 in.	CM/SM/LEM QDA19866 QDA19886	5
Platform IVA	310 ft	CM/SM valve box QDA19905	5
Platform IVA	310 ft	Purge manifold #5	

*Refer to table A-3 of appendix A.

Recommended number of sensors: Six Type 5.

TABLE 5

NITROGEN TETROXIDE LINES*

Area	Level	Location	Sensor Type
MAT-oxidizer servicing unit	-22 ft 0 in.	QDA19814 QDA19817 QDA19856	5
MAT	-22 ft 0 in.	Purge manifold #1 Purge manifold #2	5
MAT IT	-	QDA19845 QDA19846 FHA20086 QDA19855 QDA19854 FHA20092	5
MAT IT	-22 ft 0 in.	QDA19841 QDA19840 FHA20084	5
PAD-Transfer unit		QDA19832 QDA19825 QDA19839 QDA19844 QDA19829	5
Off-pad area disposal unit		QDA19853	5
Off-pad area ready storage unit		QDA19828 QDA19831	5
MAT SM/LEM propulsion system, isolation valve box 264 ft 3 in.	264 ft 3 in.	QDA19847 QDA19874 QDA19890 QDA19842 QDA19876 QDA19892	5
MAT CM/SM/LEM isolation valve box	264 ft 3 in.	QDA19818 QDA19864 QDA19870 QDA19880 QDA19815	5
Platform III LEM propulsion system valve box		Line cap	None
Platform IVA SM valve box		QDA19911 QDA19909	5

*Refer to tables A-4 through A-12 of appendix A.

Recommended number of sensors: Type 5: 10.

TABLE 6

MONOMETHYLHYDRAZINE LINES*

Area	Level	Location	Sensor Type
MAT-CM-RCS fuel servicing unit	-22 ft 0 in.	QDA19939 QDA19941 QDA19942 QDA19943	4,5
Platform IVA CM-RCS fuel valve	310 ft 7-1/2 in.	QDA19938 QDA19940	4,5

*Refer to tables A-13 through A-15 of appendix A.

Recommended number of sensors: rec -- Type 4: 2; Type 5: 2.

TABLE 7

AEROZINE-50*

Area	Level	Location	Sensor Type
Off-pad area	Ready storage unit	QDA19960 QDA19963	4 5
Pad area	Fuel transfer unit	QDA19959 QDA19998 QDA19964 QDA19993 Purge manifold #6	4,5
MAT IF	15 ft -22 ft 0 in.	QDA19992 QDA19991 QDA19997 QDA19996 Under FHA20109 Under FHA20107	4,5
MAT SM/LEM	264 ft 3 in.	QDA19957 QDA19990 QDA19995 QDA20016 QDA20012 QDA20032 QDA20026 QDA20014 Purge manifold #10 QDA19961 QDA20010 QDA20030	4,5
Platform IVA SM/SPS fuel valve box	310 ft 7-1/2 in.	QDA20041 QDA20039 QDA20043 QDA20045	4,5
Platform III LEA propulsion system valve box		QDA20028 Line cap	4,5
MAT SM/LEM res servicing unit		QDA19958 QDA19962	4,5

*Refer to tables A-17 through A-28 of appendix A.

Recommended number of sensors -- Type 4: 7; Type 5: 7.

TABLE 8

LIQUID OXYGEN LINES*

Area	Level	Location	Sensor Type
MAT-transfer unit	-22 ft 0 in.	MVA20130	2
MAT IT		BAY A20080 Purge manifold #2 FHA20082 BAY A20071	2
MAT		Purge manifold #3	2
MAT transfer unit		MVA20132	2
Pipe chase		Purge manifold #4	
MAT CM/SM/LEM in LOX valve box	264 ft 3 in.	Valve box	2
Platform III-LEM-LOX valve box		Valve box	2
Platform IVA SM LOX valve box		Valve box	2
Pad area-storage unit		MVA20131 PRVA20181 Purge manifold #1	2

*Refer to table A-29 of appendix A.

Recommended number of sensors -- Type 2: 8.

TABLE 9

LIQUID HYDROGEN LINES*

Area	Level	Location	Sensor Type
MAT LH_2 transfer unit	-22 ft 0 in.	MVA20156	2
		MVA20152	2
		FHA20118	2
		PRVA20184	2,4
		FHA20117	2
		Purge manifold #8	1,2 4**
		Transfer unit (entire)	4
MAT LH_2 EPS isolation valve box	264 ft 3 in.	Valve box	1,2
		Purge manifold #10	1,2
Platform III LEM EPS LH_2 valve box		Valve box	1,2,4
		Purge manifold #9**	
Platform IVA SM EPS LH_2 valve box		Valve box**	1,2,4
LH_2 storage unit-pad area		MVA20157	2
		FHA20115	2
		PRVA20183	2,4
		FHA20116	2
MAT IT	-22 ft 0 in.	BAY A20073	2
		FHA22095	2
		BAY A20072	2
		Purge manifold #7	1,2,4

*Refer to table A-30 of appendix A.

**Type 1: General monitors hot wire; Type 2: ultrasonic; Type 4: UV.

Recommended number of sensors -- Type 1: 6; Type 2: 18; Type 4: 2.

Additional for ascending lines -- Type 2: 6 (spaced along line).

5. CONCLUSIONS

The placement of sensors is predicated on the fact that valves and quick-disconnects are the most logical leak areas. However, it is not required that sensors be placed at each potential leak area, since many of the lines are placed relatively close together at the manifolds, pipe housing, etc. Thus, the required number of sensors will be less than would appear necessary at first glance. Since the drawings of the fueling system are also subject to revision, and a number of errors are apparent (as noted in the tables of the appendix), an attempt to delineate specific brackets for attachment, and, indeed to establish the precise number of sensors for particular areas, is felt to be unwarranted at this time. It is expected that the corrections and changes which are to be made in construction of the system will require on-site placement of sensors, utilizing this report as a guide rather than as an absolute requirement. For this reason, although the hazardous areas are noted and recommendations made, a great deal of latitude has been allowed in sensor placement.

APPENDIX A

ANALYSIS OF FUEL AND OXIDIZER PIPING

INTRODUCTION

Tables A-1 through A-30 of this appendix show the detailed analysis of fuel and oxidizer flow derived from drawing set 75M14574, which served as a basis for the sensor selection and location.

LIST OF TABLES

LIST OF TABLES (Continued)

TABLE A-1

FUEL VAPOR

(LINES 7-0, 7-1, 7-2, 7-3, AND 7-4)

Drawing No. and Level	Flow of Main Lines	Flow of Sub Lines	Type of Connection and No.*
9 MAT-22 ft 0 in. Fuel side	1. Line 7-0 begins: S14-063(NAA) S/M & LEM RCS Fuel Servicing Unit		FH (B)-QD-A19969(23)
		Line 7-1 begins: S14-064(NAA) C/M - RCS Fuel Servicing Unit	FH (A)-QD-A19935(23)
	2. Intersects line 7-1		CL
	3. Passes through Purge Manifold 7		CL
See Drawing No. 15	(a). Connects w/line 48-42		
9 Interface tower Fuel side 0 ft 0 in.	4. Line passes from MAT to Interface Tower		QD(at MAT) - A19970(23) FH(MAT-IF tower)-A20097(23) QD(on IF tower)-A19971(23)
9 PAD Area Fuel side approx. 15 ft	5. Passes through Purge Manifold 6		CL
	(a). Connects w/line 47-11		
		Line 7-2 begins: S14-008 Fuel Transfer and Conditioning Unit	FH (C)-QD-A19949(23)
	6. Intersects line 7-2		CL

*Drawing number in parentheses.

TABLE A-1 (Continued)

FUEL VAPOR (LINES 7-0, 7-1, 7-2, 7-3, AND 7-4)

Drawing and and Level	Flow of Main Line	Flow of Sub Lines	Type of Connection and No.*
9 OFF PAD Area Fuel side	Line 7-0	Line 7-3 begins: S14-058 Fuel Ready Storage Unit	FH (E)- QD-A19989(23)
	Intersects line 7-3		CL
		Line 7-4 begins: Intersection of Lines 7-0 and 7-3	CL
		Line 7-4 ends: S14-060 Fuel Vapor Disposal Unit	QD-A19984(23) FH (B)-

See also drawings:

23, 38, 39, 40, 42, 43, 50, 51, 52, 54, 55, 114, and 121 for series 7 lines.

*Drawing number in parentheses.

TABLE A-2

TOXIC VAPOR (LINES 22-0, 22-1, AND 22-2)

Drawing No. and Level		Flow of Line	Type of Connection and No.*
10 Tower level 264 ft 3 in. Fuel side	1.	Line 22-0 begins: S/M & LEM RCS Fuel Isolation Valve Box	FH- QD-A19950(23)
	2.	Enters Fuel pipe chase (to drawing 9)	

TABLE A-2 (Continued)

TOXIC VAPOR (LINES 22-0, 22-1, AND 22-2)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
9	3. Picks up at Fuel pipe chase	
MAT - 22 ft 0 in. level Fuel side	4. Passes through Purge Manifold 8	CL
	(a). Connects w/line 48-25	
	5. Line 22-0 ends: S14-063(NAA) S/M & LEM RCS Fuel Servicing Unit	QD-A19951(23) FH (E)-
See also drawings: 52, 59, 61, 62, 67, 69, 70, 81, 114, 123, 146, and 147 for 22-0 lines continuity.		
10	1. Line 22-1 begins: LEM RCS Fuel Valve Box	Line capped
Platform III Fuel side	2. Passes through Purge Manifold 9 connects w/49-27	CL
Tower level 264 ft 3 in. Fuel side	3. Line 22-1 ends: S/M & LEM RCS Fuel Isolation Valve Box	QD-A20020(24) FH-
See also drawings: 70, 81, 82, 83, 84, 85, 86, 87, 123, and 146 for 22-1 continuity.		

*Drawing number in parentheses.

TABLE A-2 (Continued)

TOXIC VAPOR (LINES 22-0, 22-1, AND 22-2)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
10 Platform IVA Fuel side	1. Line 22-2 begins: S/M RCS Fuel Valve Box	FH QD-A20049(25)
	2. Passes through Purge Manifold 10 (a). connects w/line 49-35	CL
Tower level 264 ft. 3 in. Fuel side	3. Line 22-2 ends: S/M & LEM RCS Fuel Isolation Valve Box	QD-A20036(25) FH -

See also drawings:
91, 92, 100, 101, 102, 103, 105, 108, 117, and 124.

*Drawing numbers in parentheses.

TABLE A-3

TOXIC VAPOR (LINES 30-0, 30-1, AND 30-2)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
8 Tower level 264 ft 3 in. Oxidizer side	1. Line 30-0 begins: C/M, S/M, LEM RCS Oxidizer Isolation Valve Box	FH QD-A19821
	2. Enters Oxidizer pipe chase (to drawing 7)	
7 Pipe Chase	3. Picks up at Oxidizer pipe chase	

TABLE A-3 (Continued)

TOXIC VAPOR (LINES 30-0, 30-1, AND 30-2)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
7 MAT - 22 ft 0 in. level Oxidizer side	4. Passes through Purge Manifold 3 (a). connects w/line 48-12	CL
	5. Line 30-0 ends: S14-057(NAA) Oxidizer Servicing Unit	QD-A 19820(20) FH (E)
See also drawings: 45, 56, 57, 58, 63, 67, 68, 70, 71, 76, 115, 122, 146, and 147.		
8 Platform III Oxidizer side	1. Line 30-1 begins: LEM RCS Oxidizer Valve Box 430-64460-3	Line capped
	2. Passes through Purge Manifold 4 (a). connects w/line 49-11	CL
8 Tower level 264 ft 3 in. Oxidizer side	3. Line 30-1 ends: C/M, S/M, LEM RCS Oxidizer Isolation Valve Box	QD-A19866(21) FH-
See also drawings: 70, 71, 72, 73, 74, 75, 77, 78, 79, 122, and 146.		

*Drawing number in parentheses.

TABLE A-3 (Continued)

TOXIC VAPOR (LINES 30-0, 30-1, AND 30-2)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
8 Platform IVA Oxidizer side	1. Line 30-2 begins: C/M & S/M RCS Oxidizer Valve Box	FH- QD-A19905(22)
	2. Passes through Purge Manifold 4 (a). connects w/line 49-20	CL
8 Tower level 264 ft 3 in. Oxidizer side	3. Line 30-2 ends: C/M, S/M, LEM RCS Oxidizer Isolation Valve Box	QD-A19886(22) FH-

See also drawings:

89, 90, 93, 94, 98, 118, and 124.

TABLE A-4

N_2O_4 (LINES 8-0, 8-1, AND 8-2)

Drawing No. and Level	Flow of Main Line	Flow of Sub Lines	Type of Connection and No.*
7 MAT -22 ft 0 in. Oxidizer side	1. Line 8-0 begins: S14-057(NAA) Oxidizer Servicing Unit		FH (A)- QD-A19856(20)
(See drawing No. 12)	2. Passes through Purge Manifold 2 (a). connects w/line 48-13		CL

TABLE A-4 (Continued)

N_2O_4 (LINES 8-0, 8-1, AND 8-2)

Drawing No. and Level	Flow of Main Line	Flow of Sub Lines	Type of Connection and No.
7	3. Line passes from MAT to Interface Tower		QD(at MAT) - A19855(20) FH(MAT-IF tower)- A20092(20)
	4. Passes through Purge Manifold 1		QD(on IF tower)- A19854(20)
(See drawing No. 11)	(a). connects w/line 46-9		CL
7 PAD Area Oxidizer side		Line 8-1 begins: S14-002 Oxidizer Transfer and Conditioning Unit	FH (C)- QD-A19825(20)
	5. Intersects line 8-1		CL
7 OFF PAD Area Oxidizer side		Line 8-2 begins: S19-059 Oxidizer Ready Storage Unit	FH (F)- QD-A19837(20)
	6. Intersects line 8-2		CL
	7. Line 8-0 ends: S14-061 Oxidizer Vapor Disposal Unit		QD-A19853(20) FH (B)-

See also drawings:

20, 32, 33, 35, 36, 44, 48, 49, 115, 119, and 121.

*Drawing number in parentheses.

TABLE A-5

N_2O_4 (LINE 13-0)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
7 OFF Pad Area Oxidizer Side	1. Line 13-0 begins: S14-059 Oxidizer Ready Storage Unit**	FH (C)- QD-A19831(20)
7 Pad Area Oxidizer Side See also drawings: 32, 33, and 35.	2. Line 13-0 ends: S14-002 Oxidizer Transfer and Conditioning Unit	QD-A19832(20) FH (B)-

*Drawing number in parenthesis.

**Purged w/line 46-1 from Purge Manifold 1. (From drawing No. 11)

TABLE A-6

N_2O_4 (LINE 14-0)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
7 PAD Area Oxidizer Side	1. Line 14-0 begins: S14-002 Oxidizer Transfer and Conditioning Unit	FH (D)- QD-A19844(20)
See drawing No. 11	2. Passes through Purge Manifold 1 (a). connects w/line 46-3	CL
	3. Passes into Interface Tower	

TABLE A-6 (Continued)
N_2O_4 (LINE 14-0)

Drawing No. and Level		Flow of Line	Type of Connection and No.*
7			
MAT -22 ft 0 in. level Oxidizer Side	4.	Passes from IF tower to MAT	QD-A19845(20) FH-A20086(20) QD-A19846(20)
See drawing No. 12	5.	Passes through Purge Manifold 2 (a). connects w/line 48-15	CL
See drawing No. 12	6.	Passes through Purge Manifold 3	CL
7			
Oxidizer Pipe Chase	7.	Enters Oxidizer Pipe Chase (to 8)	
8			
	8.	Picks up at Oxidizer Pipe Chase	
See drawing No. 13	9.	Passes through Purge Manifold 5	CL
8			
Tower Level 264 ft 3 in. Oxidizer Side	10.	Line 14-0 ends: S/M & IEM Prop. Sys. Oxid. Isolation Valve Box	QD-A19847(20 FH-

See also drawings:

33, 35, 36, 44, 48, 49, 63, 67, 68, 70, 71, 119, 121, 122, 146, and 147.

*Drawing number in parentheses.

TABLE A-7

N_2O_4 (LINE 14-1)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
8 Tower Level 264 ft 3 in. See drawing No. 13	1. Line 14-1 begins: S/M & LEM Prop. Sys. Oxid. Isolation Valve Box 2. Passes through Purge Manifold 5 (4) (a). connects w/line 49-4	FH QD-A19874(21) CL
8 Platform III Oxidizer Side	3. Line 14-1 ends: LEM Propulsion System Oxidizer Valve Box 430-64420-7	Line capped

See also drawings:

70, 71, 72, 73, 75, 77, 78, 79, 122, and 146.

*Drawing number in parentheses.

TABLE A-8

N_2O_4 (LINE 14-2)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
8 Tower level 264 ft 3 in. Fuel side See drawing No. 13	1. Line 14-2 begins: S/M & LEM Prop. Sys. Oxid. Isolation Valve Box 2. Passes through Purge Manifold 5 (a). connects w/line 49-13	FH- QD-A19890(22) CL

TABLE A-8 (Continued)

N_2O_4 (LINE 14-2)

Drawing No. and Level		Flow of Line	Type of Connection and No.*
8	3.	Line 14-2 ends:	
		S/M SPS	QD-A19909(22)
Platform IVA		Oxidizer Valve Box	FH-
Oxidizer Side			

See also drawings:

89, 90, 93, 94, 95, 97, 98, 99, 118, and 124.

*Drawing number in parentheses.

TABLE A-9

N_2O_4 (LINE 15-0)

Drawing No. and Level		Flow of Line	Type of Connection and No.*
8 Tower level 264 ft 3 in. Oxidizer side. See drawing No. 13	1.	Line 15-0 begins: S/M & LEM Prop. Sys. Oxid. Isolation Valve Box	FH- QD-A19842(20)
	2.	Passes through Purge Manifold 5	CL
Pipe Chase (to drawing 7)	3.	Enters Oxidizer Pipe Chase	
7 Pipe Chase	4.	Picks up at Oxidizer Pipe Chase	
7 MAT -22 ft 0 in. Oxidizer side	5.	Passes through Purge Manifold 3 (a). connects w/line	CL
See drawing No. 12	6.	Passes through Purge Manifold 2 (a). connects w/line 48-17	CL
7	7.	Passes from MAT 22 ft 0 in. to Interface Tower	QD-A19841(20) FH-A20084(20) QD-A19840(20)
7 PAD Area Oxidizer side See drawing No. 11	8.	Passes through Purge Manifold 1 (a). connects w/line 46-5	CL
	9.	Line 15-0 ends: S14-002 Oxidizer Transfer and Conditioning Unit	QD-A19839(20) FH (F)

See also drawings:

33, 35, 36, 44, 48, 49, 63, 67, 68, 70, 71, 119, 121, 122, 146, and 147.

*Drawing number in parentheses.

TABLE A-10

N_2O_4 (LINES 15-1, 15-2)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
8 Platform III Oxidizer side	1. Line 15-1 begins: LEM Propulsion System Oxidizer Valve Box 430-64420-7	Line capped
See drawing No. 13	2. Passes through Purge Manifold 5 (a). connects w/line 49-3	CL
8 Tower level 264 ft 3 in. Oxidizer side	3. Line 15-1 ends: S/M & LEM Prop. Sys. Oxid. Isolation Valve Box	QD-A19876(21) FH-
See also drawings: 70, 71, 72, 73, 75, 77, 78, 79, 122, and 146.		
8 Platform IVA Oxidizer side	1. Line 15-2 begins: S/M SPS Oxidizer Valve Box	FH QD-A19911(22)
See drawing No. 13	2. Passes through Purge Manifold 5 (a). connects w/line 49-12	CL
8 Tower level 264 ft 3 in. Oxidizer side	3. Line 15-2 ends: S/M & LEM Prop. Sys. Oxid. Isolation Valve Box	QD-A19892(22) FH-
See also drawings: 89, 90, 93, 94, 95, 97, 98, 99, 118, and 124.		

*Drawing number in parentheses.

TABLE A-11

N_2O_4 (LINE 16-0)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
7 PAD Area Oxidizer side	1. Line 16-0 begins: S14-002 Oxidizer Transfer and Conditioning Unit**	FH (E) QD-A19829(20)
7 OFF PAD Area Oxidizer side	2. Line 16-0 ends: S14-059 Oxidizer Ready Storage Unit	QD-A19828(20) FH (D)

See also drawings:

32, 33, and 35.

*Drawing number in parentheses.

**Purged w/line 46-2 from Purge Manifold 1. (See drawing No. 11)

TABLE A-12

N_2O_4 (LINES 27-0, 27-1, 27-2, 28-0, 28-1, AND 28-2)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
7 MAT -22 ft 0 in. Oxidizer side	1. Line 27-0 begins: S14-059(NAA) Oxidizer Servicing Unit	FH (H) QD-A19817(20)
	2. Passes through Purge Manifold 3 (a). connects w/line 48-9	CL
7 Oxidizer Pipe Chase	3. Enters Oxidizer Pipe Chase (to drawing 8)	

TABLE A-12 (Continued)

N_2O_4 (LINES 27-0, 27-1, 27-2, 28-0, 28-1, AND 28-2)

Drawing No. and Level		Flow of Line	Type of Connection and No.*
8	4.	Picks up at Oxidizer Pipe Chase	
8 Tower level 264 ft 3 in. Oxidizer side	5.	Line 27-0 ends: C/M, S/M, LEM RCS Oxidizer Isolation Valve Box	QD-A19818(20) FH-
See also drawings: 45, 56, 57, 58, 63, 67, 68, 70, 71, 76, 115, 146, and 147.			
8 Tower level 264 ft 3 in. Oxidizer side	1.	Line 27-1 begins: C/M, S/M, LEM RCS Oxidizer Isolation Valve Box	FH QD-A19864(20)
See drawing No. 13	2.	Passes through Purge Manifold 4 (a). connects w/line 49-9	CL
8 Platform III Oxidizer side	3.	Line 27-1 ends: LEM RCS Oxidizer Valve Box 430-64460-3	Line capped
See also drawings: 70, 71, 72, 73, 74, 75, 77, 78, 79, 122, and 146.			

*Drawing number in parentheses.

TABLE A-12 (Continued)

N_2O_4 (LINES 27-0, 27-1, 27-2, 28-0, 28-1, AND 28-2)

Drawing No. and Level		Flow of Line	Type of Connection and No.*
8 Tower level 264 ft 3 in. Oxidizer side	1.	Line 27-2 begins: C/M, S/M, LEM RCS Oxidizer Isolation Valve Box	FH- QD-A19880(22)
See drawing No. 13	2.	Passes through Purge Manifold 4 (a). connects w/line 49-17	CL
8 Platform IVA Oxidizer side	3.	Line 27-2 ends: C/M & S/M RCS Oxidizer Valve Box	QD-A19899(22) FH-
See also drawings: 89, 90, 93, 94, 95, 97, 98, 118, and 124.			
8 Tower level 264 ft. 3 in. Oxidizer side	1.	Line 28-0 begins C/M, S/M, LEM RCS Oxidizer Isolation Valve Box	FH- QD-A19815(20)
Pipe Chase	2.	Enters Oxidizer Pipe Chase (to drawing 7)	
7 Oxidizer Pipe Chase	3.	Picks up at Oxidizer Pipe Chase	
7 MAT -22 ft 0 in. Oxidizer side	4.	Passes through Purge Manifold 3 (a). connects w/line 48-10	CL

*Drawing number in parentheses.

TABLE A-12 (Continued)

N_2O_4 (LINES 27-0, 27-1, 27-2, 28-0, 28-1, AND 28-2)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
8 Tower level 264 ft 3 in. Oxidizer side	1. Line 28-0 begins: C/M, S/M, LEM RCS Oxidizer Isolation Valve Box	FH- QD-A19815(20)
Pipe Chase	2. Enters Oxidizer Pipe Chase (to drawing 7)	
7 Oxidizer Pipe Chase	3. Picks up at Oxidizer Pipe Chase	
7 MAT -22 ft 0 in. Oxidizer side	4. Passes through Purge Manifold 3 (a). connects w/line 48-10	CL
	5. Line 28-0 ends: S14-057(NAA) Oxidizer Servicing Unit	QD-A19814(20) FH-
See also drawings: 45, 56, 57, 58, 63, 67, 68, 70, 71, 76, 115, 122, 146, and 147.		
8 Platform III Oxidizer side	1. Line 28-1 begins: LEM RCS Oxidizer Valve Box 430-64460-3	Line capped
See drawing No. 13	2. Passes through Purge Manifold 4 (a). connects w/line 49-8	CL

* Drawing number in parentheses.

TABLE A-12 (Continued)

N_2O_4 (LINES 27-0, 27-1, 27-2, 28-0, 28-1, AND 28-2)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
8 Tower level 264 ft 3 in. Oxidizer side	3. Line 28-1 ends: C/M, S/M, LEM RCS Oxidizer Isolation Valve Box	QD-A19870(20) FH-
See also drawings: 70, 71, 72, 73, 74, 75, 77, 78, 79, 122, and 146.		
8 Platform IVA Oxidizer side	1. Line 28-2 begins: C/M & S/M RCS Oxidizer Valve Box	FH- QD-A19901(22)
See drawing No. 13	2. Passes through Purge Manifold 4 (5) (a). connects w/line 49-18	CL
8 Tower level 264 ft 3 in. Oxidizer side	3. Line 28-2 ends: C/M, S/M, LEM RCS Oxidizer Isolation Valve Box	QD-A19882(22) FH-
See also drawings: 89, 90, 93, 94, 95, 97, 98, 118, and 124.		

*Drawing number in parentheses.

TABLE A-13

MONOMETHYLHYDRAZINE (LINE 23-0)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
9 MAT -22 ft 0 in. level Fuel side	1. Line 23-0 begins: S14-064(NAA) C/M-RCS Fuel Servicing Unit	FH (H) QD-A19941(23)
See drawing No. 15	2. Passes through Purge Manifold 8 (a). connects w/line 48-30	CL
9 Pipe chase	3. Enters Pipe Chase (to drawing No. 10)	
10 Pipe chase	4. Picks up at fuel pipe chase	
10 Platform IVA Fuel side	5. Line 23-0 ends: C/M RCS Fuel Valve Box	QD-A19940(23) FH-

See also drawings:

51, 59, 61, 62, 65, 67, 69, 70, 81, 91, 92, 100-105, 108, 114, 117, 146, and 147.

*Drawing number in parentheses.

TABLE A-14

MONOMETHYLHYDRAZINE (LINE 24-0)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
10 Platform IVA Fuel side	1. Line 24-0 begins: C/M RCS Fuel Valve Box	FH QD-A19938(23)
	2. Enters Fuel Pipe Chase (to drawing No. 9)	

TABLE A-14 (Continued)

MONOMETHYLHYDRAZINE (LINE 24-0)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
9 Pipe Chase	3. Picks up at Fuel Pipe Chase	
9 MAT -22 ft 0 in. level Fuel side	4. Passes through Purge Manifold 8 (a). connects w/line 48-32	CL
	5. Line 24-0 ends: S14-064(NAA) C/M-RCS Fuel Servicing Unit	QD-A19939(23) FH (G)

See also drawings:

51, 59, 61, 62, 65, 67, 69, 70, 81, 83, 91, 92, 100-105, 108, 114, 117, 146, and 147.

*Drawing number in parentheses.

TABLE A-15

VACUUM VAPOR TOXIC (LINE 26-0)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
10 Platform IVA Fuel side	1. Line 26-0 begins: C/M RCS Fuel Valve Box	FH QD-A19942(23)
	2. Enters Fuel Pipe chase (to sheet 9)	
9 MAT -22 ft 0 in. level Fuel side	3. Picks up at Fuel pipe chase	

TABLE A-15 (Continued)

VACUUM VAPOR TOXIC (LINE 26-0)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
	4. Passes through Purge Manifold 8 (a) Connects w/line 48-31	CL
	5. Line 26-0 ends: S14-064 (NAA) C/M - RCS Fuel Servicing Unit	QD-A19943(23) FH (E)

See also drawings:
51, 59, 60, 61, 62, 65, 67, 69, 70, 81, 83, 91, 100, 101, 102, 103, 105, 108, 114, 117, 146, and 147.

*Drawing number in parentheses.

TABLE A-16

AEROZINE-50 (UDMH and N_2H_4) (LINE 9-0)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
9 Off PAD Area Fuel side	1. Line 9-0 begins: S14-058 Fuel Ready Storage Unit	FH (C) QD - A19963(23)
9 PAD Area Fuel side	2. S14-008 Fuel Transfer and Conditioning Unit	QD - A19964(23) FH (B)
14 PAD Area Fuel side	3. Between steps (1) and (2) purged w/line 47-2	CL

See also drawings:
23, 38, 39, 40, 42, and 52.

*Drawing number in parentheses.

TABLE A-17

AEROZINE-50 (UDMH and N_2H_4) (LINE 10-0)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
9 PAD Area Fuel side	1. Line 10-0 begins: S14-008 Fuel Transfer and Conditioning Unit	FH (D) QD - A19998(23)
	2. Passes through Purge Manifold 6 (a) Connects w/line 47-6	CL
9 Interface Tower - Fuel side Approx. 15 ft.	3. Enter Interface tower	
	4. Passes from IF tower to MAT -22 ft 0 in. level	QD (on IF tower) - A19997(23) FH (IF tower-MAT) - A20109(23) QD (on MAT) - A19996(23)
9 MAT -22 ft 0 in. Fuel side	5. Passes through Purge Manifold 7 (a) Connects w/line 48-37	CL
	6. Passes through Purge Manifold 8 (a) Connects w/line	CL
9 Fuel Pipe Chase to sheet 10	7. Enters Fuel Pipe Chase	
10 PAD Area	8. Line 10-0 picks up from Fuel Pipe Chase - sheet 9	
10 Tower Level 264 ft 3 in. Fuel side	9. Line 10-0 ends: S/M LEM Prop. System Isolation Valve Box	QD - A19995(23) FH

See also drawings:
39, 40, 42, 43, 50, 52, 54, 55, 65, 67, 69, 70, 81, 82, 83, 120, 121, 123, 146, and 147.

*Drawing number in parentheses.

TABLE A-18

AEROZINE-50 (UDMH and N_2H_4) (LINE 10-1)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
10 Tower level 264 ft 3 in. Fuel side	1. Line 10-1 begins: S/M LEM Prop. System Isolation Valve Box	FH QD - A20012(24)
	2. Passes through Purge Manifold 9 (a) Connects w/line 49-30	
10 Platform III Fuel side	3. Line 10-1 ends: LEM Prop. System Fuel Valve Box 64420-5	Line capped

See also drawings:
70, 81, 82, 83, 84, 85, 86, 87, 123, and 146.

*Drawing number in parentheses.

TABLE A-19

AEROZINE-50 (UDMR and N_2H_4) (LINE 10-2)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
10 Tower level 264 ft 3 in. Fuel side	1. Line 10-2 begins: S/M LEM Prop. System Isolation Valve Box	FH QD - A20026(25)
	2. Passes through Purge Manifold 10 (a) Connects w/line 49-38	CL

TABLE A-19 (Continued)

AEROZINE-50 (UDMH and N_2H_4) (LINE 10-2)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
10 Platform IVA Fuel side	3. Line 10-2 ends: S/M SPS Fuel Valve Box	QD - A20039(25) FH

See also drawings:
91, 92, 100, 101, 103, 104, 105, 107, 117, and 124.

*Drawing number in parentheses.

TABLE A-20

AEROZINE-50 (UDMH and N_2H_4) (LINE 11-0)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
10 Tower level 264 ft 3 in. Fuel side	1. Line 11-0 begins: S/M LEM Prop. System Isolation Valve Box	FH QD - A19990(23)
10 PAD Area	2. Enters Fuel Pipe Chase	
9 Fuel Pipe Chase from sheet 10	3. Picks up from Fuel Pipe Chase on sheet 10	
9 MAT -22 ft 0 in. Level Fuel side	4. Passes through Purge Manifold 8	CL
	5. Passes through Purge Manifold 7 (a) Connects w/line 48-38	CL

TABLE A-20 (Continued)

AEROZINE-50 (UDMH and N_2H_4) (LINE 11-0)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
9 Interface Tower Fuel side	6. Passes from MAT to Interface Tower	QD(on MAT)-A19991(23) FH(MAT-IF tower)-A20107(23) QD (on IF tower) - A19992(23)
	7. Passes to PAD Area	
9 PAD Area Fuel side	8. Passes through Purge Manifold 6 (a) Connects w/line 47-7	CL
	9. Line 11-0 ends: S14-008 Fuel Transfer and Conditioning Unit	QD - A19993(23) FH (F)

See also drawings:
39, 40, 42, 43, 50, 52, 54, 55, 65, 67, 69, 70, 81, 82, 120, 121, 123, 146, and 147.

*Drawing number in parentheses.

TABLE A-21

AEROZINE-50 (UDMH and N_2H_4) (LINE 11-1)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
10 Platform III Fuel side	1. Line 11-1 begins: LEM Prop. SYS Fuel Valve Box 64420-5	Line capped
	2. Passes through Purge Manifold 9 (a) Connects w/line 49-31	
10 Tower level 264 ft 3 in. Fuel side	3. Line 11-1 ends: S/M LEM Prop. System Isolation Valve Box	QD-A20014(24) FH

See also drawings:
70, 81, 82, 83, 84, 85, 86, 87, 123, and 146.

*Drawing number in parentheses.

TABLE A-22

AEROZINE-50 (UDMH and N_2H_4) (LINE 11-2)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
10 Platform IVA Fuel side	1. Line 11-2 begins: S/M SPS Fuel Valve Box	FH QD - A20041(25)
	2. Passes through Purge Manifold 10 (a) Connects w/line 49-39	CL
10 Tower level 264 ft 3 in. Fuel side	3. Line 11-2 ends: S/M LEM Prop. System Isolation Valve Box	QD - A20028(25)

See also drawings:
91, 92, 100, 101, 103, 104, 105, 107, 117, and 124.

*Drawing numbers in parentheses.

TABLE A-23

AEROZINE-50 (UDMH and N_2H_4) (LINE 12-0)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
9 PAD area Fuel side	1. Line 12-0 begins: S14-008 Fuel Transfer and Conditioning Unit	FH (E) QD - A19959(23)
9 Off PAD Area Fuel side	2. S14-058 Fuel Ready Storage Unit	QD - A19960(23) FH (D)
14 PAD Area Fuel side	3. Between steps (1) and (2) purged w/line 47-1	CL

See also drawings:
23, 38, 39, 40, 42, and 52.

*Drawing number in parentheses.

TABLE A-24

AEROZINE-50 (LINES 19-0 AND 19-1)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
9 MAT - 22 ft 0 in. level Fuel side	1. Line 19-0 begins: S14-063 (NAA) S/M & LEM RCS Fuel Servicing Unit	FH (H) QD - A19962(23)
See drawing No. 15	2. Passes through Purge Manifold 8 (a) Connects w/line 48-28	CL
Pipe Chase	3. Enters Fuel pipe chase (to drawing No. 10)	

TABLE A-24 (Continued)

AEROZINE -50 (LINES 19-0 AND 19-1)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
10 Pipe Chase	4. Picks up at Fuel Pipe Chase	
10 Tower level 264 ft 3 in. Fuel side	5. Line 19-0 ends: S/M & LEM RCS Fuel Isolation Valve Box	QD - A19961(23) FH
See also drawings: 52, 59, 61, 62, 65, 67, 69, 70, 81, 82, 114, 123, 146, and 147.		
10 Tower level 264 ft 3 in. Fuel side	1. Line 19-1 begins: S/M & LEM RCS Fuel Isolation Valve Box	FH QD - A20010(24)
	2. Passes through Purge Manifold 9 (a) Connects w/line 49-24	
10 Platform III Fuel side	3. Line 19-1 ends: LEM RCS Fuel Valve Box 64460-1	Line capped
See also drawings: 70, 81, 82, 83, 84, 85, 86, 87, 123, and 146.		

*Drawing number in parentheses.

TABLE A-25

AEROZINE-50 (LINE 19-2)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
10 Tower level 264 ft 3 in. Fuel side	1. Line 19-2 begins: S/M & LEM RCS Fuel Isolation Valve Box	FH QD - A20030(25)
	2. Passes through Purge Manifold 10 (a) Connects w/line 49-32	CL
10 Platform IVA Fuel side	3. Line 19-2 ends: S/M RCS Fuel Valve Box	QD - A20043(25) FH

See also drawings:
91, 92, 101, 102, 103, 104, 105, 108, 117, 124.

*Drawing number in parentheses.

TABLE A-26

AEROZINE-50 (LINE 20-0)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
10 Tower level 264 ft 3 in. Fuel side	1. Line 20-0 begins: S/M & LEM RCS Fuel Isolation Valve Box	FH QD - A19957(23)
Pipe Chase	2. Enters Fuel Pipe Chase (to drawing No. 9)	
9 Pipe Chase	3. Picks up at Fuel Pipe Chase	

TABLE A-26 (Continued)

AEROZINE-50 (LINE 20-0)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
9 MAT -22 ft 0 in. level Fuel side	4. Passes through Purge Manifold 8 (a) Connects w/line 48-27	CL
See drawing No. 15	5. Line 20-0 ends: S14-063 (NAA) S/M & LEM RCS Fuel Servicing Unit	QD - A19958(23) FH (G)

See also drawings:
52, 59, 61, 62, 65, 67, 69, 70, 81, 82, 114, 123, 146, and 147.

*Drawing number in parentheses.

TABLE A-27

AEROZINE-50 (LINE 20-1)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
10 Platform III Fuel side	1. Line 20-1 begins: LEM RCS Fuel Valve Box 64460-1	Line capped
	2. Passes through Purge Manifold 9 (a) Connects w/line 49-25	
10 Tower level 264 ft 3 in. Fuel side	3. Line 20-1 ends: S/M & LEM RCS Fuel Isolation Valve Box	FH QD - A20016(24)

See also drawings:
70, 82, 83, 84, 85, 86, 87, 123, and 146.

*Drawing number in parentheses.

TABLE A-28

AEROZINE-50 (LINE 20-2)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
10 Platform IVA Fuel side	1. Line 20-2 begins: S/M RCS Fuel Valve Box	FH QD - A20045(25)
	2. Passes through Purge Manifold 10 (a) Connects w/line 49-33	CL
10 Tower level 264 ft 3 in. Fuel side	3. Line 20-2 ends: S/M & LEM RCS Fuel Isolation Valve Box	QD -(A20032) (25) FH

See also drawings:
91, 92, 101, 102, 103, 105, 108, 117, and 124.

*Drawing number in parentheses.

TABLE A-29

VACUUM JACKETED LIQUID OXYGEN (LINES 39-0, 39-1, 39-2, AND 41-0)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
7 MAT -22 ft 0 in. Oxidizer side	1. Line 39-0 begins: S14-032 LO_2 Transfer Unit	F.C.(D) M.V. - A20130(20)
	2. Line has a "T" which vents to atmosphere	CL FH - A20119(20) PRV - A20182(20)
See drawing No. 12	3. Passes through Purge Manifold 3 (a) connects w/line 48-5	CL
7 Pipe Chase	4. Enters Oxidizer Pipe Chase (to 8)	
8 Pipe Chase	5. Picks up at Pipe Chase	
See drawing No. 13	6. Passes through Purge Manifold 4	CL
8 Tower level 264 ft 3 in. Oxidizer side	7. Line 39-0 ends: C/M, S/M, & LEM LO_2 Isolation Valve Box	L.W.

See also drawings:
46, 56, 57, 58, 63, 64, 67, 68, 70, 71, 76, 146 and 147.

*Drawing number in parentheses.

TABLE A-29 (Continued)

VACUUM JACKETED LIQUID OXYGEN (LINES 39-0, 39-1, 39-2, AND 41-0)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
8 Tower level 264 ft 3 in. Oxidizer side	1. Line 39-1 begins: C/M, S/M & LEM LO_2 Isolation Valve Box	L.W.
See drawing No. 13	2. Passes through Purge Manifold 4 (a) Connects w/line 49-7	CL
8 Platform III Oxidizer Side	3. Line 39-1 ends: LEM LO_2 EPS Valve Box 430-84330	L.W.
See also drawings: 70, 71, 72, 73, 74, 77, 80, 86, and 146.		
8 Tower level 264 ft 3 in. Oxidizer side	1. Line 39-2 begins: C/M, S/M & LEM LO_2 Isolation Valve Box	L.W.
See drawing No. 13	2. Passes through Purge Manifold 4 (a) Connects w/line 49-14	CL
8 Platform IVA Oxidizer side	3. Line 39-2 ends: S/M LO_2 Valve Box	L.W.
See also drawings: 89, 90, 93, 97, and 98.		

*Drawing number in parentheses.

TABLE A-29 (Continued)

VACUUM JACKETED LIQUID OXYGEN (LINES 39-0, 39-1, 39-2, AND 41-0)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
7 PAD Area Oxidizer side	1. Line 41-0 begins: S14-065 LO_2 Storage Unit	FC(E) MV - A20131(20)
	2. Line has "T" venting to atmosphere	CL FH - A20114(20) PRV - A20181(20)
See drawing No. 11	3. Passes through Purge Manifold 1 (a) Connects w/line 46-7	CL
7 Interface tower Oxidizer side	4. Line enters IF tower	
7 MAT - 22 ft 0 in. level Oxidizer side	5. Line passes from IF tower to MAT-22'	Bay. - A20070(20) FH - A20082(20) Bay. - A20071(20)
See drawing No. 12	6. Passes through Purge Manifold 2 (a) Connects w/line 48-20	CL
7 MAT -22 ft 0 in. level Oxidizer side	7. Line 41-0 ends: S14-032 LO_2 Transfer Unit	M.V. - A20132(20) F.C.

See also drawings:
33, 34, 35, 36, 44, 46, 48, 49, 119, and 121.

*Drawing number in parentheses.

TABLE A-30

VACUUM JACKETED LIQUID HYDROGEN (LINES 31-0, 31-1, 31-2, AND 34-0)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
9 MAT -22 ft 0 in. level Fuel side	1. Line 31-0 begins: S14-026 LH_2 Transfer Unit	F.C. (D) M.V. - A20152(23)
	2. Line has a "T" venting to line 5-0 (which vents to facility disposal	F.H. - A20118(23) P.R.V. - A20184(23) F.H. - A20117(23)
See drawing No. 15	3. Passes through Purge Manifold 8 (a) Connects w/line 48-23	CL
	4. Line enters Fuel Pipe Chase (to sheet 10)	
10 Pipe Chase	5. Picks up at Fuel Pipe Chase	
10 Tower level 265 ft 3 in. Fuel side	6. Line 31-0 ends: C/M, S/M, LEM LH_2 EPS Isolation Valve Box	L.W.
See also drawings: 53, 59, 61, 62, 65, 66, 67, 70, 81, 146, and 147.		
10 Tower level 264 ft 3 in. Fuel side	1. Line 31-1 begins: C/M, S/M, LEM LH_2 EPS Isolation Valve Box	L.W.
	2. Passes through Purge Manifold 9 (a) Connects w/line 49-29	C.L.

*Drawing number in parentheses.

TABLE A-30 (Continued)

VACUUM JACKETED LIQUID HYDROGEN (LINES 31-0, 31-1, 31-2, AND 34-0)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
10 Platform III Fuel side See also drawings: 81, 82, 83, 84, 85, and 146.	3. Line 31-1 ends: LEM EPS LH_2 Valve Box 430-84310	L.W.
10 Tower level 264 ft 3 in. Fuel side	1. Line 31-2 begins: C/M, S/M, LEM LH_2 EPS Isolation Valve Box	L.W.
	2. Passes through Purge Manifold 10 (a) Connects w/line 49-36	CL
10 Platform IVA Fuel Side See also drawings: 81, 91, 92, 101, 102, and 103.	3. Line 31-2 ends: S/M EPS LH_2 Valve Box	L.W.
9 PAD Area Fuel side	1. Line 34-0 begins: S14-066 LH_2 Storage Unit	F.C. (E) M.V. - A20157(23)
See drawing No. 14	2. Passes through Purge Manifold 6 (a) Connects w/line 47-3	CL

*Drawing number in parentheses.

TABLE A-30 (Continued)

VACUUM JACKETED LIQUID HYDROGEN (LINES 31-0, 31-1, 31-2, AND 34-0)

Drawing No. and Level	Flow of Line	Type of Connection and No.*
	3. Line has a "T" which vents to line 5-0 (which vents to facility disposal)	CL (w/FH) F.H. - A20115(23) PRV - A20183(23) F.H. - A20116(23)
9 Interface Tower	4. Line passes onto Interface Tower	
	5. Line passes from IF Tower to MAT -22 ft 0 in.	Bay. - A20073(23) FH - A20095(23) Bay. - A20072(23)
9 MAT -22 ft 0 in. level Fuel side	6. Passes through Purge Manifold 7 (a) Connects w/line 48-34	CL
9 MAT -22 ft 0 in. level Fuel side	7. Line 34-0 ends: S14-026 LH_2 Transfer Unit	M.V. - A20156(23) F.C. (C)

See also drawings:
39, 40, 41, 42, 43, 50, 52, 53, 54, 55, 120, and 121.

*Drawing number in parentheses.